Space Weather Technical Forecast

Issued on Monday, 22 November 2021 at 00:45 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Now decreased Chance of Active 24-hour electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low over the last 24 hours, with no significant X-ray flare activity observed at GOES-16. There are two sunspot-containing active regions on the visible disc, both small and stable: AR2896, which is now an Hrx/Alpha, and AR2897, which underwent slight decay to become an Axx/Alpha.

There are currently two large filaments in southern disc, however these appear to be stable at the time of writing. There were some changes in the shape and appearance of coronal hole 21 near the northern crown through the UTC day, perhaps explaining changes seen in a streamer on STEREO A COR2, however this is angled above the ecliptic plane to no expected effect at Earth. In addition to this, there were two late Coronal Mass Ejection (CME) candidates seen leaving the southeastern and northwestern limbs at around 21/2100UTC, however these have yet to show on available satellite imagery, and in any case Earth-based effects are again not expected.

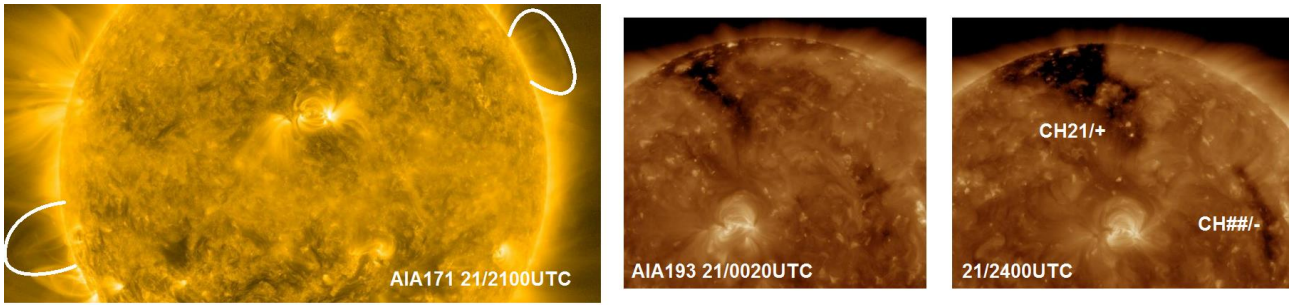

Figure 0: Noteworthy events on the disc during the UTC day of Sunday 21 November: (Left) Near-simultaneous limb eruptions seen on AIA171; (Centre, Right) changes to northern crown coronal hole, CH21, and possible development of a minor new coronal hole in the west.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, remained characteristic of connection to a strong negative polarity high speed stream, most likely that emanating from coronal hole 20. The solar wind speed was elevated to strong, rising from the low-500s of km/s into the upper 600s, with peaks just shy of 700km/s for a time. This trend reversed during the second half of the UTC day of Sunday, ending the 24 hours near starting levels. The solar wind density was generally around 10ppcc throughout, while the interplanetary magnetic field strength (IMF) Bt, peaked at 9nT, with a north-south component varying between -6 and +7nT. The phi angle was predominately negative (towards the Sun) throughout.

The net result of the above solar wind measures was nevertheless provisionally Quiet Kp indices,

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with provisional Unsettled peaks of '3+' in the 00-03UTC and 15-18UTC intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured by GOES-16 remained at Background levels. The high energy electron flux (greater than 2 MeV) was predominantly at Moderate levels, peaking at 712pfu at 21/1515UTC. The associated 24-hour integrated fluence remained below the Active threshold (1e8 integrated pfu), with a near-level trend, recording 1.5e7 integrated pfu at 22/0000 UTC.

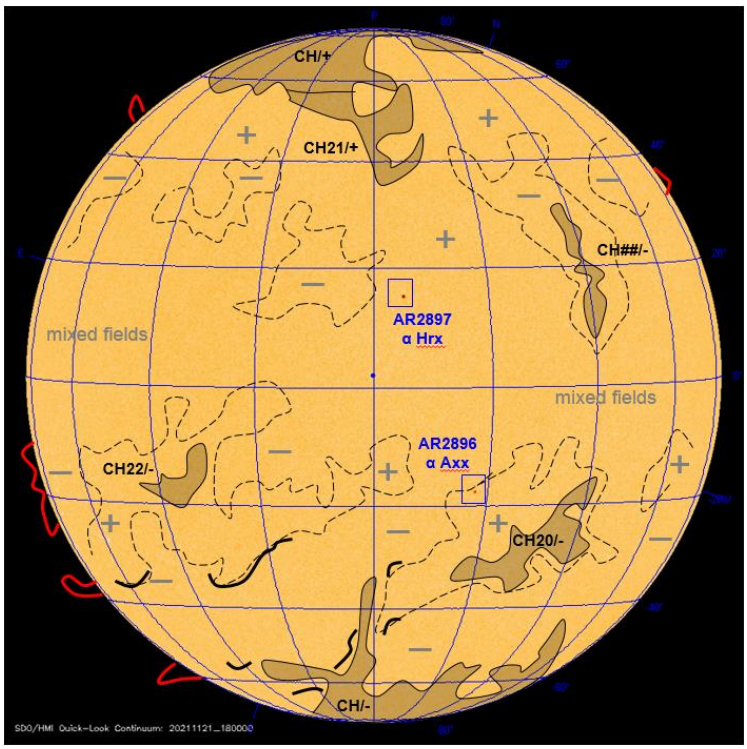
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Very Low, with only a slight chance of C-class flares due to the two small and simple sunspots on the Earth-facing disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the current forecast. Earth's current interaction with the fast wind of CH20 is expected to be the peak of activity for the period, with Quiet to Unsettled conditions, with periods of Active. This should fall to become mostly Quiet by midweek, with a low confidence upturn ending the four days should CH22 follow on. This final feature is not expected to result in G1.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels. The high energy electron flux (greater than 2 MeV) is expected to rise as geomagnetic activity wanes from the current fast wind. The magnitude of this rise is uncertain, however diurnal oscillations peaking at High flux (greater than 1000 pfu) are likely. The associated 24-hour integrated fluence has a chance of breaching Active (greater than 1e8 integrated pfu) in the period, but more likely remaining just below this level.

Figure 1. Solar Analysis Valid 21/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in the current forecast.

The fast wind from coronal hole 20 is likely the main driver of any enhanced geomagnetic activity in the coming four days, with geomagnetic activity gradually falling from an initial peak. Beyond this feature, a new unnumbered coronal hole appears to have opened in the northwest of the disc in the past 24 hours, however as a visibly rather tenuous entity, this is not expected to have a notable impact on the forecast. In terms of the longer range, CH21/+, the southern extension of the northern crown is perhaps too far northward to have any impact on solar winds at Earth, while CH22/- in the eastern solar hemisphere is open to significant uncertainty. This final coronal hole is not a persistent feature, and it currently lies too far eastward to register at STEREO A. As a cursory initial assessment - being both smaller and fainter than the current coronal hole - any uptick in activity at the end of the four days is thought unlikely to result in G1 - perhaps most frequently Unsettled with a Slight Chance of isolated Active intervals. Thoughts on CH22 will be updated as and when it manifests at STEREO A.

Despite solar winds speeds of near 700km/s being observed at L1 at the peak of CH20/-, geomagnetic activity remained more muted than expected. Quiet to Unsettled activity is Expected to start the UTC working week, with Active periods possible. This activity is expected to wane to become mainly Quiet by midweek, with the possibility of a limited late resurgence should CH22 materialise to round out the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Radio Blackouts - X-Ray Flares:

There are currently two sunspot-containing active regions on the visible disc: AR2896. which has been analysed as an Hrx/Alpha; and AR2897, which is now considered an Axx/Alpha.

STEREO A EUVI 195 imagery hints that Ex-2891 may lie narrowly over the eastern limb, perhaps impacting on probabilities of flares into the new week, although for now Very Low solar activity is forecast, with a daily Slight Chance (5%) of C-class flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16, remained at Background levels during the previous 24 hours, and is currently forecast to remain at this level through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

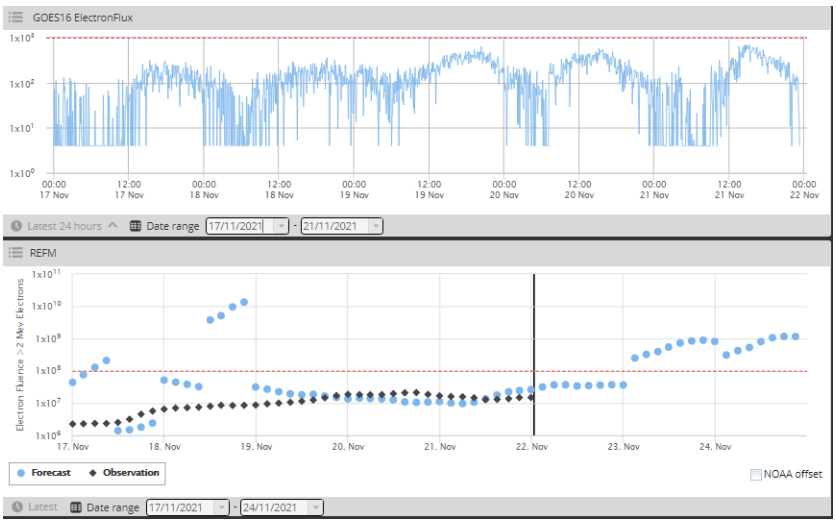
The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO has been at mainly Moderate levels, but may rise to High, especially during the diurnal observation peak. This is most likely to occur once any compression of the Van Allen belts from the current fast wind of CH20/- subsides. This will give a peak Chance of 24-hour electron fluence exceeding Active during the first half of this coming working week, although confidence in this aspect is relatively low, especially due to the lack of a relevant analogue on last rotation.

At the very end of the period, question marks regarding a possible new high speed stream from coronal hole 22 may again compress the Van Allen belts, resulting in a final modest reduction in the risk of Active fluence. Midweek levels of fluence are then probably unlikely to be restored into the next UTC weekend given the expected slower windspeeds involved in CH22 when compared with CH20, as discussed in the Geomagnetic Activity section.

MOSWOC REFM indicates an increasing risk of breaching Active in the next 48 hours, although the muted geomagnetic response to the fast wind suggests that this risk is lower than REFM signals, and perhaps delayed over its expectations.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 2: Past five days in GOES 16 high energy electron flux, showing very modest rising trend day-on-day, despite seeing two 600km/s+ high speed streams in succession from CH19 and CH20. Also shown is REFM and 24-hour fluence observations – note the trend is expected to be upwards, although the degree to which this occurs remains uncertain for flux being unusually unresponsive to CH19 and now CH20 thus far.



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